

[RP] REPRODUCING A CLIMATE CHANGE VULNERABILITY MODEL FOR MALAWI



Middlebury
College

JOSEPH HOLLER, MIDDLEBURY COLLEGE
KUFRE UDOH, MIDDLEBURY COLLEGE
PETER KEDRON, ARIZONA STATE UNIVERSITY

contact: josephh@middlebury.edu

WHY REPRODUCE VULNERABILITY MODELS?

“Reproducibility is obtaining consistent results using the same input data, computational steps, methods, and code, and conditions of analysis.” (NASEM 2019, 36)

- ◆ Independently **verify** and **improve** previous studies
- ◆ Increase **transparency**, **credibility**, **trust**, and **reproducibility**
- ◆ **Accelerate** pace of scientific progress
- ◆ **Broaden** the **impacts** of vulnerability studies in science, policy, and public decision-making
- ◆ Transform **pedagogy** through **project-based learning** with reproduction and replication studies of contemporary research
- ◆ Advance research on **uncertainty** and **validation** of geographic models of vulnerability and adaptive capacity
- ◆ Sub-national vulnerability models inform studies of **distributional justice** and **efficacy** of **climate change adaptation**
- ◆ Incorporate **vulnerability models** into **synthesis & convergence** research easily by practicing **open science**

DATA SOURCES

Public:

- ◆ United Nations Environment Programme (UNEP) Global Disaster Risk Platform grids of Flood Risk and Physical exposure to drought
- ◆ GADM Administrative Boundaries Version 2.8 (November 2015) second administrative level (traditional authorities)
- ◆ Famine Early Warning System Network (FEWS NET) Livelihood Zones (2009)

With Approved Proposal & Data Agreement:

- ◆ United States Agency for International Development (USAID) Demographic and Health Survey (2005) with GPS Points

Not Public:

- ◆ FEWS NET / Malawi Vulnerability Assessment Committee (MVAC) Household Economy

METHODS

17 undergraduate students attempted the replication in Fall 2019 in an advanced Open Source Geographic Information Science course.

- ◆ Collaboratively drafted **PostGIS** queries to solve the **Adaptive Capacity** meta-theme based on metadata
- ◆ Holler ran the queries and provided outputs aggregated into 3rd administrative level (Traditional Authorities) to class
- ◆ Class implemented **QGIS graphic model** and **GRASS** tools to solve the **Physical Exposure** meta-theme and integrate the Adaptive Capacity and Physical Exposure meta-themes
- ◆ Results **visualized** in **QGIS** and **published** on **GitHub**.
- ◆ Kufre Udoh revisited and implemented the analysis in **R**.

REPRODUCTION OF:

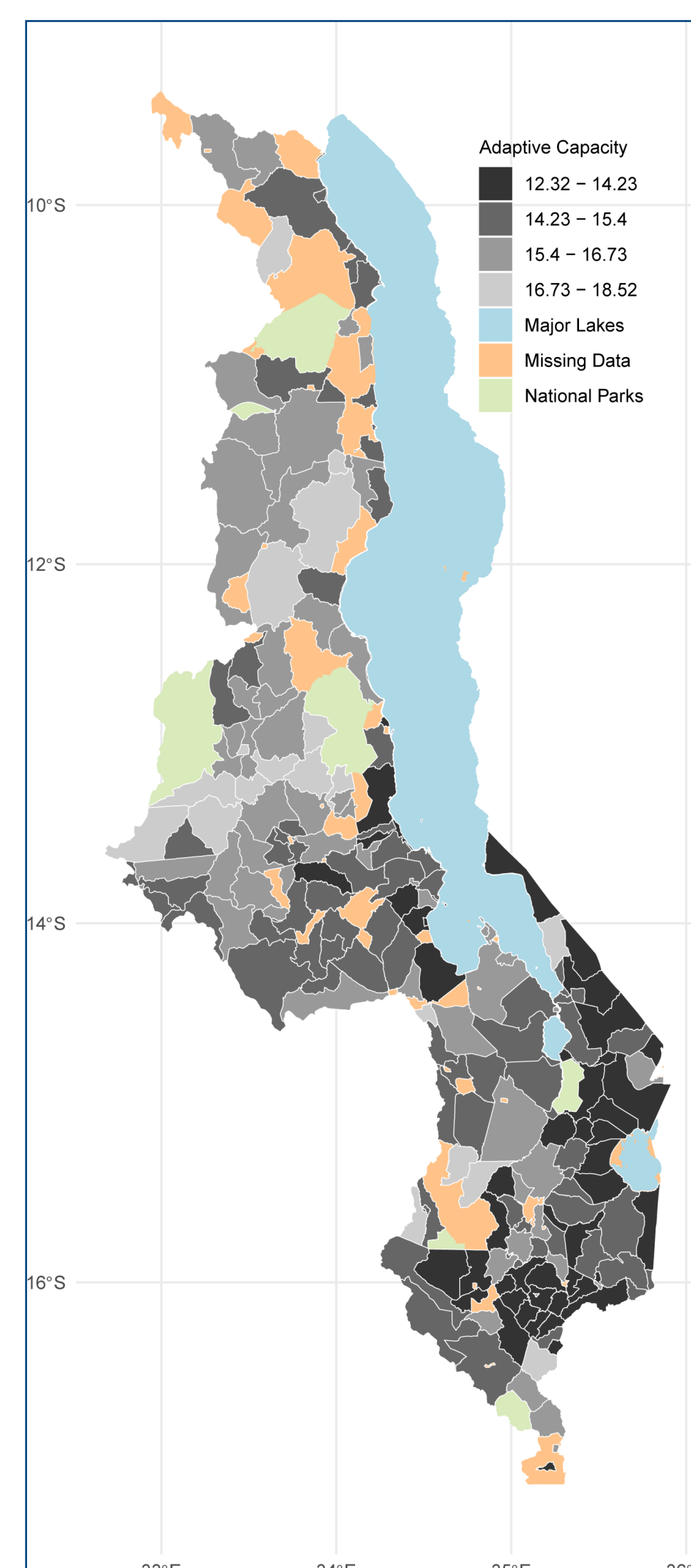
Malcomb, D. W., E. A. Weaver, and A. R. Krakowka. 2014. Vulnerability modeling for sub-Saharan Africa: An operationalized approach in Malawi. *Applied Geography* 48:17–30.

- ◆ Early adopter of subnational vulnerability modeling in developing countries
- ◆ **40 citations** on Google Scholar as of April 8, 2021
- ◆ Thorough narrative description of methodology feasible for undergraduate GIS students
- ◆ After reading, we *expected this paper to be reproducible*.

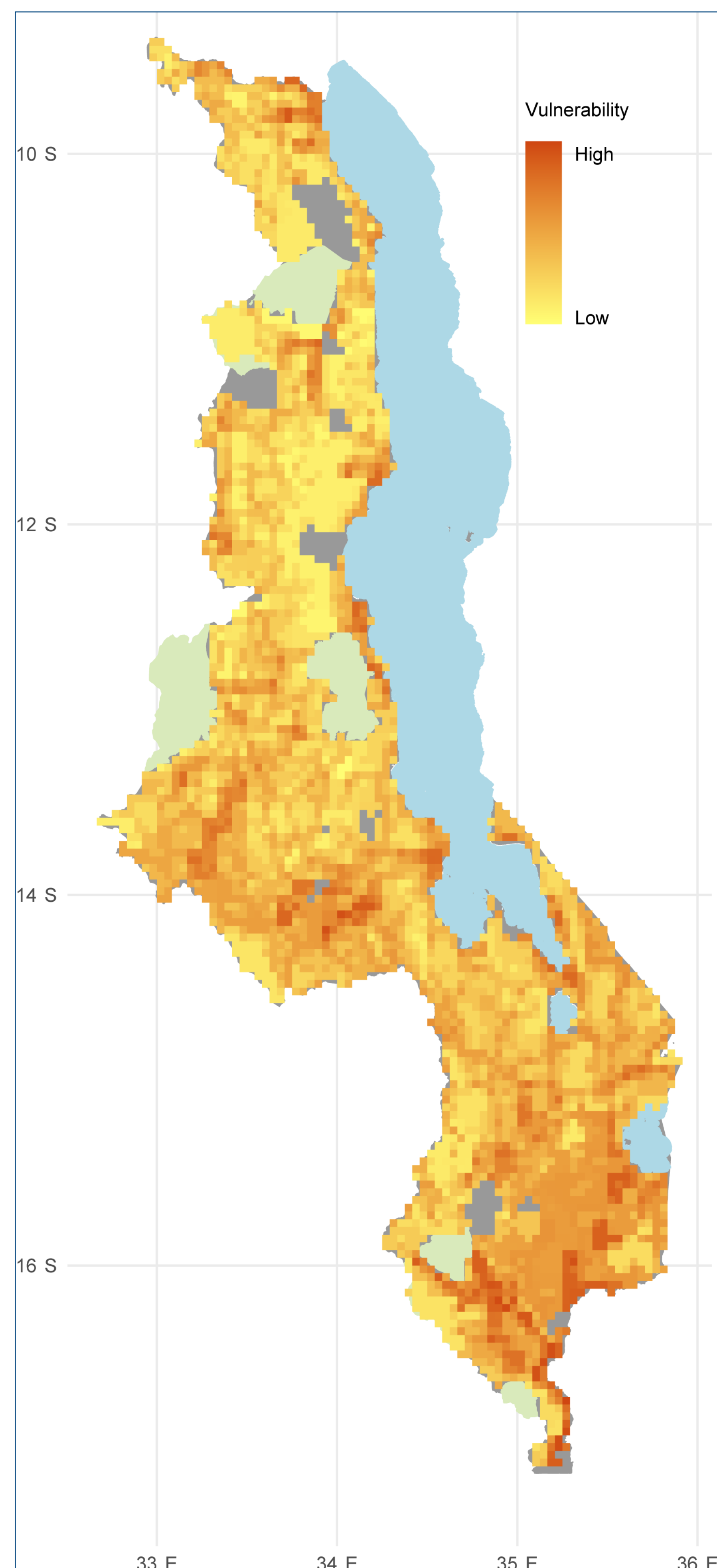
RESULTS

- ◆ To date, we have **not succeeded** in exactly reproducing the original results.
- ◆ See gis4dev.github.io Spring 2019 Students for individual results
- ◆ See gis4dev/RP-Malcomb GitHub repository for a draft research compendium with executable R by Kufre Udoh

ADAPTIVE CAPACITY



VULNERABILITY



DISCUSSION

Data and methods **availability** ranges between *unavailable* and *findable* and completeness is *partially described*. Barriers and uncertainties in (this) reproduction include:

- ◆ Rescaling from nominal data to quintiles
- ◆ Treatment of missing data in DHS surveys & geometry data errors in GADM
- ◆ Versions or dates of data sources
- ◆ MVAC/FEWS NET Household Economy Approach survey not available to the public and USAID DHS data is available only through a project approval process
- ◆ Language and descriptions for indicators change within the paper and between the paper, data providers, and metadata. Some data providers mislabel files or variables while some indicators are composites or derivatives of other variables.
- ◆ Few descriptive statistics with which to check intermediary results and calculations
- ◆ We may **reproduce** the same **results**, but cannot **replicate** theoretical relationship without **model validation**: a significant weakness in the science of vulnerability modeling.
- ◆ Need for **reproducible research compendium** with **data** and **executable code**

FUTURE WORK

- ◆ GitHub research compendium for reproducible geographic science!
- ◆ Provide mechanism for access to FEWS NET HEA data
- ◆ Develop R code to compare reproduction results with original results using weighted Spearman's Rho correlation
- ◆ Parameterize uncertain decisions and test for more accurate solutions through either manual analysis or *monte carlo* simulation.
- ◆ Account for random displacement of DHS GPS data by 5km
- ◆ Scale up review of reproducibility in vulnerability modeling
- ◆ Develop vulnerability theory through replication of validated models
- ◆ Evaluate project-based learning outcomes from studying methods through reproduction and replication attempts.

REFERENCES

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